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FOUNDATION ENGINEERING REPORT SANTA CLARA FLOOD CONTROL AND WATER CONSERVATION DISTRICT SANTA CLARA COUNTY, CALIFORNIA

PUMO NO. 58-32

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13 June 1958

FOUNDATION ENGINEERING REPORT SANTA CLARA FLOOD CONTROL AND WATER CONSERVATION DISTRICT SANTA CLARA COUNTY, CALIFORNIA

PUMO NO. 58-32

I. INTRODUCTION

A Foundation Engineering Investigation has been performed at the Stevens and Permanente Creek sites designated by the Santa Clara County Engineer's Office. This report describes field and laboratory portions of the program, along with conclusions and recommendations based upon these findings.

A. Authorization. This program was authorized by George H. Prime, Supervising Engineer, Flood Control Section, County of Santa Clara, in a letter dated 26 March 1958. Site location plans and levee details were supplied by the County Engineer's Office.

B. Purpose and Scope. This program was authorized to determine the foundation conditions that will be encountered in the realignment of Stevens and Permanente Creek. The proposed angles of cut for the new channel sections along Stevens and Permanente Creek were investigated for stability purposes. The materials available from the borrow areas indicated by test borings P-1 through P-5, P-18 and P-19 were studied to determine their suitability for use in levees to be constructed in the locations shown by test borings P-8 through P-17. These same levees

SANTA CLARA VALLEY WATER DISTRICT
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were investigated for stability purposes and to determine their safety against seepage. Test borings P-2 and P-3 were studied to determine foundation conditions with respect to supporting the proposed Bridge Improvement Program at Moffett Blvd. crossing over Stevens Creek.

The scope of work for this project was to consist of a field exploration supported by laboratory testing to the extent necessary for adequate determination of the physical and mechanical properties of the soil at the site.

II. FIELD INVESTIGATION

The field investigation consisted of 19 test borings drilled to depths ranging from 10 to 50 feet at locations indicated on the Site Location Plans, Plates No. 1 and 2. Borings P-1, P-4 through P-8, P-11, P-13, and P-15 through P-19 were accomplished by a Williams 12-inch diameter, auger-type rig. Sampling was accomplished with a 2-inch diameter open Porter Sampler pushed into the soil by a 30-inch pull-down chain. Borings P-2 and P-3 were accomplished by means of a "Gow" wash rig. Undisturbed sampling at these locations was accomplished with a 2-inch diameter Standard Penetration Split Spoon Sampler driven by means of a 140-pound hammer dropping 30 inches. Blow counts for the sampler were recorded and are indicated on the Soils Boring Profile, Plate No. 3. Borings P-9, P-10, P-12, and P-14 were accomplished with a 4-inch hand auger. Sampling was accomplished with a 2-inch diameter California Hand Sampler driven by means of a 25-pound hammer dropping 18 inches. All samples were visually classified at the time of sampling and were then capped and sealed to prevent loss of moisture during transportation to the soils laboratory.

No field survey was initiated to correlate the test boring elevations with any fixed datum. Elevations of test borings P-1 through P-8, P-18 and P-19 were based on elevation of average natural ground above mean sea level. Maps showing the elevation of the natural ground above mean sea level along Stevens and Permanente Creek were provided by the County of Santa Clara. Elevations of test borings P-9 through P-17 were based on assumed elevations above water table elevations approximated by field observations on dates of accomplishing the test borings.

III. LABORATORY TESTING

Undisturbed samples were submitted to the Soils Laboratory for determination of in-place unit weight, natural moisture content, classification, shear strength, and consolidation characteristics. Classification, moisture content, unit weight, and shear data are indicated upon the soils profile plates (see Plates No. 1, 2 and 3). Shear strength characteristics were determined by means of unconfined compression tests. Results of consolidation tests are attached as Plates No. 4, 5, 6 and 7.

Classification of the materials encountered at the site was based upon the Unified Soil Classification System. This system is based upon grain size distribution and plasticity characteristics of the soils.

Plasticity characteristics were determined by means of Atterberg Limits tests, the results of which are indicated on Plate No. 8. The attached Plate No. 9 is a summary of the Unified Soil Classification System.

Shear strength characteristics of the proposed levee materials were determined by means of saturated triaxial and direct shear tests on compacted samples (Plates No. 11, 13 and 15). Moisture density curves for these representative samples of the available levee materials were determined by the "Standard Method of Test for the Compaction and Density of Soils", AASHO Designation T99-49, Modified (see Plates No. 10, 12 and 14).

IV. FOUNDATION CONDITIONS

A. Stevens Creek. Test borings P-1 through P-7 are located along the Stevens Creek area. The test boring (P-1) disclosed materials consisting of approximately 10 feet of silty sand and gravel underlain by approximately 7 feet of firm sandy silty clay. Test borings P-2 and P-3 revealed a surface layer of 12 to 15 feet of expansive black clay underlain by dense sandy gravel. Test boring P-4 was drilled off the side of the dike at an elevation of + 32 through 3 feet of brown silty sand with 10 feet of expansive black clay underneath. Test boring P-5 was drilled off the side of the dike at an elevation of + 16 through 5 feet of brown sandy silts and silty sands underlain by 5 feet of expansive black clay beneath which is 5 feet of brown silty sand. Test borings P-6 and P-7 disclosed 5 feet of sands and silts underlain by 5 to 8 feet of silty clays.

✓

B. San Francisco Bay. Test borings P-8 through P-17 are located along the existing and proposed levees for that part of the Stevens Creek Channel running along the San Francisco Bay. Test borings P-8, P-9 and P-10 disclosed materials consisting of approximately 6 to 10 feet of gray organic clay underlain by firm silty and sandy clays. Test borings P-11 and P-17 were drilled off the side of the existing levee at an elevation of + 5 through 5 feet of silty sands and clays underlain by approximately 7 feet of gray organic clay beneath which is firm silty clay. Test borings P-12, P-13 and P-14 revealed a surface layer of 6 feet of gray organic clays beneath which is firm silty clay. Test borings P-15 and P-16 were drilled off the side of the existing levee at an elevation of + 2.5 through approximately 3 feet of brown silty clay underlain by 8 feet of gray organic clay beneath which is firm silty clay.

C. Permanente Creek. Test borings P-18 and P-19 are located along the Permanente Creek area. Test boring P-19 was drilled off the side of the dike at an elevation of + 16 through 6 feet of expansive black silty clay underlain by 14 feet of sandy silts and gravels. Test boring P-18 revealed a surface layer of 5 feet of silty sands and gravels underlain by approximately 6 feet of clayey sandy silt.

V. CONCLUSIONS AND RECOMMENDATIONS

Test borings P-1 through P-7 along Stevens Creek and P-18 through P-19 along Permanente Creek were investigated for the purpose of determining stability conditions with respect to the proposed channel sections. Results of our stability analyses indicate that the intended slide slopes of 1 or 1-1/2 horizontal to 1 vertical will result in adequate safety factors under conditions of saturation after complete draw down.

However, the designed channel sections requiring 4-inch concrete lining along both creeks will be constructed on expansive clays except in the vicinity of test boring P-1 along Stevens Creek, where the underlying materials will be firm clayey silts and silty clays. It has been found that cracks can be caused by uplift pressures when the expansive clays become saturated from water seeping through joints and cracks in the concrete lining. Expansion of the side slopes is not generally as serious as expansion of clays composing bottom subgrade materials, since the slope linings are less restratined against movement than are bottom linings. It is our opinion that this expansion may be controlled by placing the expansive clays as wet as the use of conventional compaction equipment will allow and at densities of approximately 80 to 85% of AASHO Designation T99-49, Modified, which will provide minimum expansion when wetted. Thus, a minimum movement should be realized for the concrete lining.

Test borings P-1 through P-5 along Stevens Creek and P-18 through P-19 along Permanente Creek were also drilled to determine if these locations can be used as borrow areas for levee materials to be used in levees along the San Francisco Bay. The materials revealed by these test borings (Plates No. 1 and 2), which consisted of gray expansive clays and firm silty clays, should be suitable for use in levees due to their impervious nature. The shear strength developed by a representative compacted sample of this levee material is shown by the unconfined compression test plotted on Plate No. 11. A direct shear test also was performed on the compacted sample and is shown on the same plate. The developed angle of internal friction of approximately 11 degrees is caused by the gravel particles of this compacted clay sample.

If enough levee materials are not available from the designated upstream borrow areas, it is our opinion that the silty sands and gravels also disclosed by borings P-1 and P-18 may be combined with the expansive clays in the area and be reasonably impervious. The shear strengths and angles of internal friction for compacted samples of combined expansive clays and sandy gravel are shown on Plates No. 13 and 15. The gradation curve for these combined materials is shown on Plate No. 16.

The proposed levee design to be used in the locations shown by test borings P-8 through P-17 utilizes side slopes of 2-1/2 or 3 horizontal to 1 vertical for a height of 10 to 14 feet. It is our opinion that these design side slopes will be adequate for levees constructed of materials encountered in the designated upstream borrow areas.

Test borings P-8 through P-14 along the length of the proposed levee indicated a surface layer of approximately 6 feet of gray organic clays. It is our opinion that if the levees can be constructed in the dry during the summer construction season, this 6 feet of organic material should be excavated down to firm silty clays and be replaced with the proposed levee materials.

It is our opinion that the proposed levees are safe with respect to seepage through and under the levees at conditions of high tide and peak flood. The materials to be used in the levees will be firm silty clays and the materials to be encountered below the levees will be impervious stiff silty clays. It is our opinion that if the levees are constructed in the dry, settlements, sloughage and required maintenance will be kept to a minimum.

If it is found to be impractical to strip out the 6 foot layer of organic material down to the firm silty clays, an alternate levee design could be utilized. The alternate design consists of a levee having side slopes of approximately 3 horizontal to 1 vertical and contains an impervious cut-off wall constructed through the organic material. The materials available from the designated upstream borrow areas are suitable in this levee design. The weight of the levee may induce settlement which could continue over a period of years. This settlement would diminish in magnitude with increasing time. Due to this possible settlement, the levee will no doubt require maintenance in order to dress up the side slopes and the top, and there may be localized failures which would require additional facing. However, it is our opinion that if these localized failures occur, they will be relatively minor in nature.

A third alternate levee could be built utilizing the organic materials on hand at locations corresponding to test borings P-8 through P-14 and found along the length of the proposed levee. This levee could be constructed by means of a clamshell operation which dredges and dumps the organic materials, with the material seeking its own angle of repose. The resulting side slopes of this levee would be approximately 5 to 6 horizontal to 1 vertical. This levee would require more material due to its smaller side slopes, would take longer to construct, and would require greater maintenance that the prior two recommended designs.

The bridge considered in our investigation of the proposed Bridge Improvement Program at Moffett Blvd. crossing over Stevens Creek was assumed to be a typical State of California Highway Bridge with a tentative pile loading of 35 tons dead load plus live load plus impact acting vertically. Materials indicated by test borings P-2 and P-3 indicate that adequate bearing materials may be reached by piles driven to tip elevations of approximately 17 feet below ground surface, in which case the piles would bear in a dense gravel stratum. It is recommended that this minimum tip elevation be checked in the field by the Engineering News Formula based on a minimum bearing value of 35 tons per concrete pile. Due to seasonal fluctuations of the water table, timber piles should not be used unless the pile cut-off elevation is below permanent ground water elevation.

The proposed 4-inch concrete lining along Stevens Creek as it flows beneath the bridge should eliminate the danger of scouring undercutting the bridge foundation. However, the possibility of scouring resulting from floods leads to our recommendation that piles be driven into the firm sandy gravel layer.

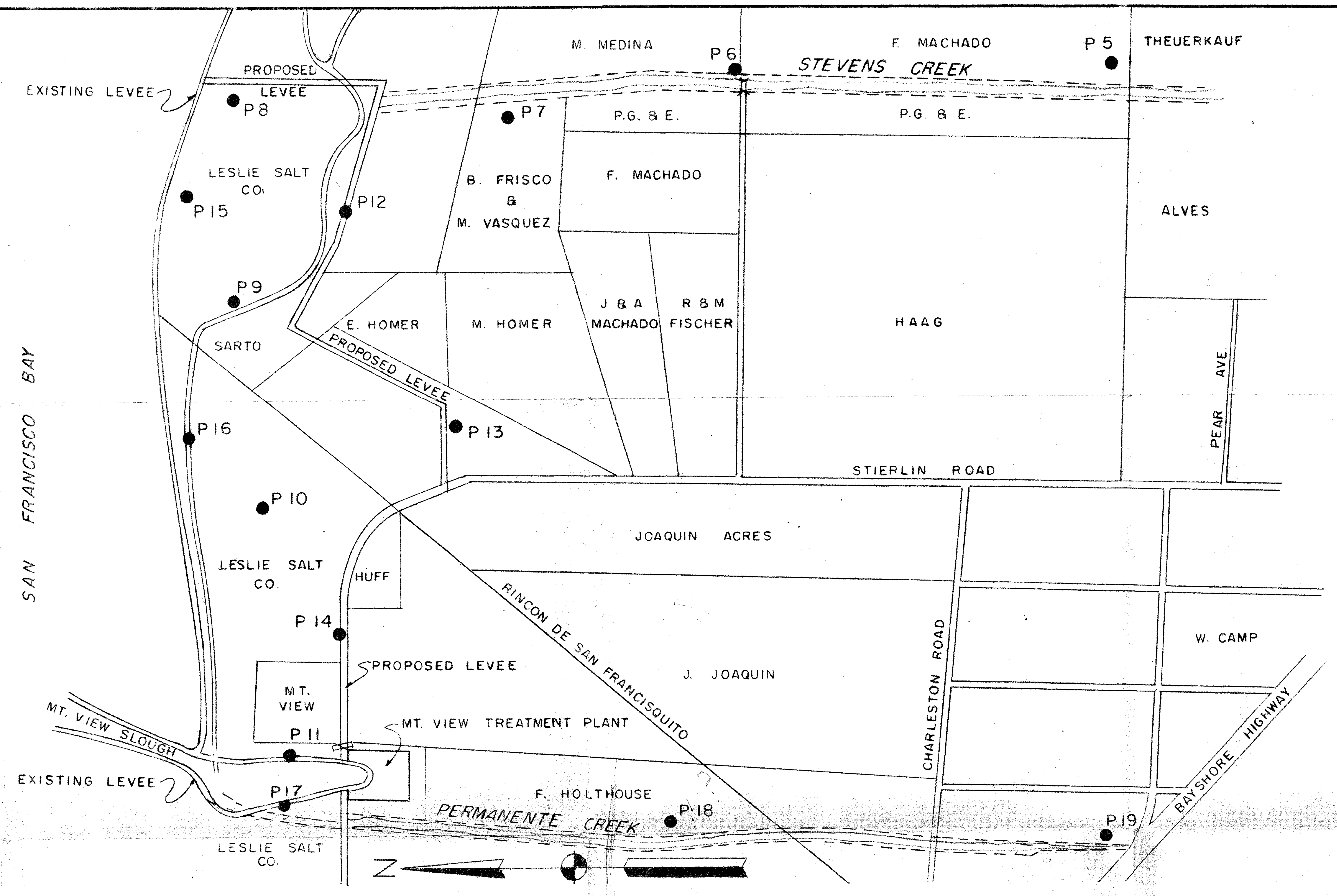
If our recommendations are followed, it is our opinion that a satisfactory bridge foundation will result from the standpoint of bearing and of future scour.

Porter, Urquhart, McCreary & O'Brien

C. L. Lowry Jr

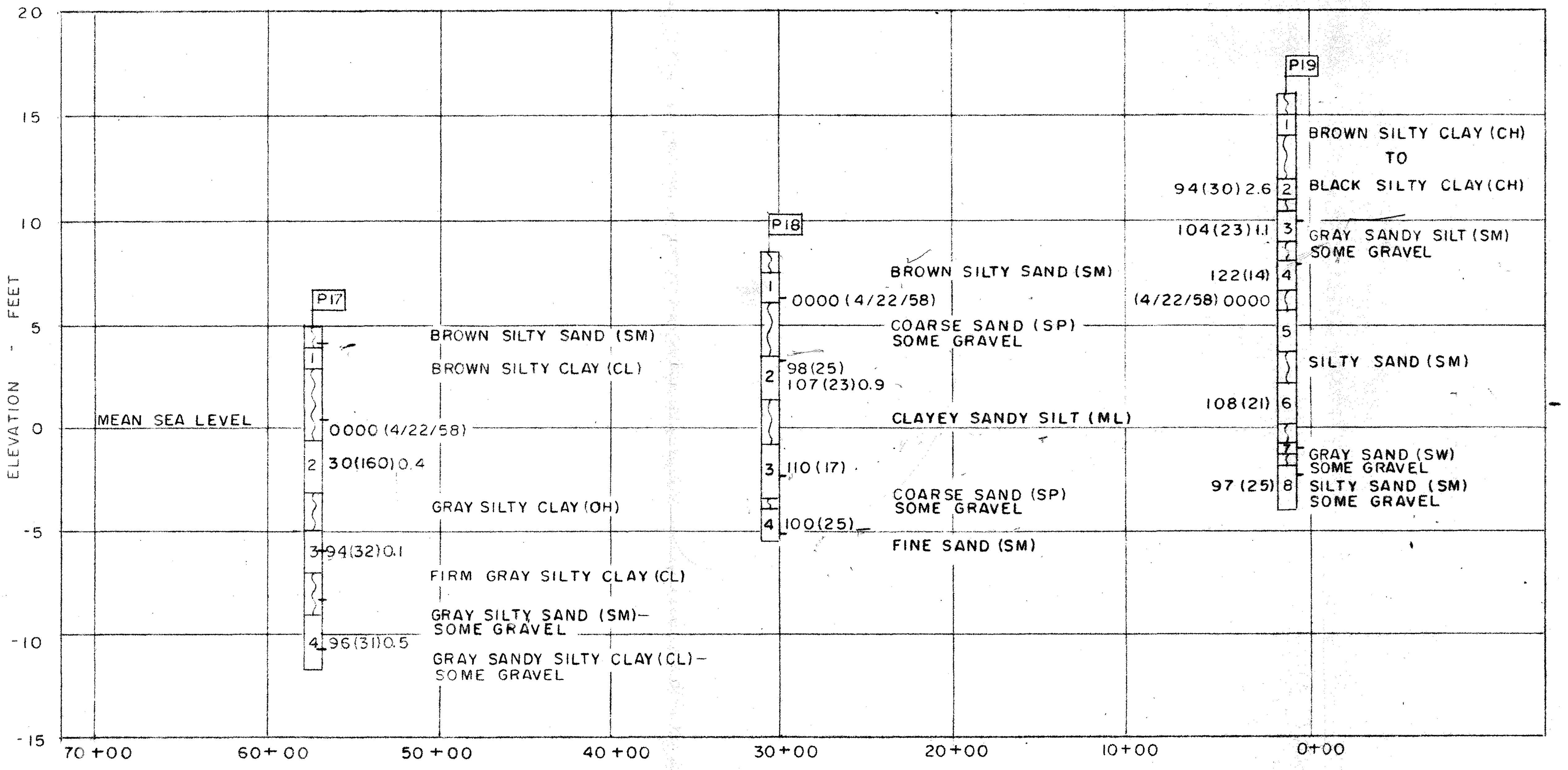
C. L. Lowry, Jr.
Registered Civil Engineer No. 9104

CLL:FWA:cs
encls.



BORING LOCATION PLAN

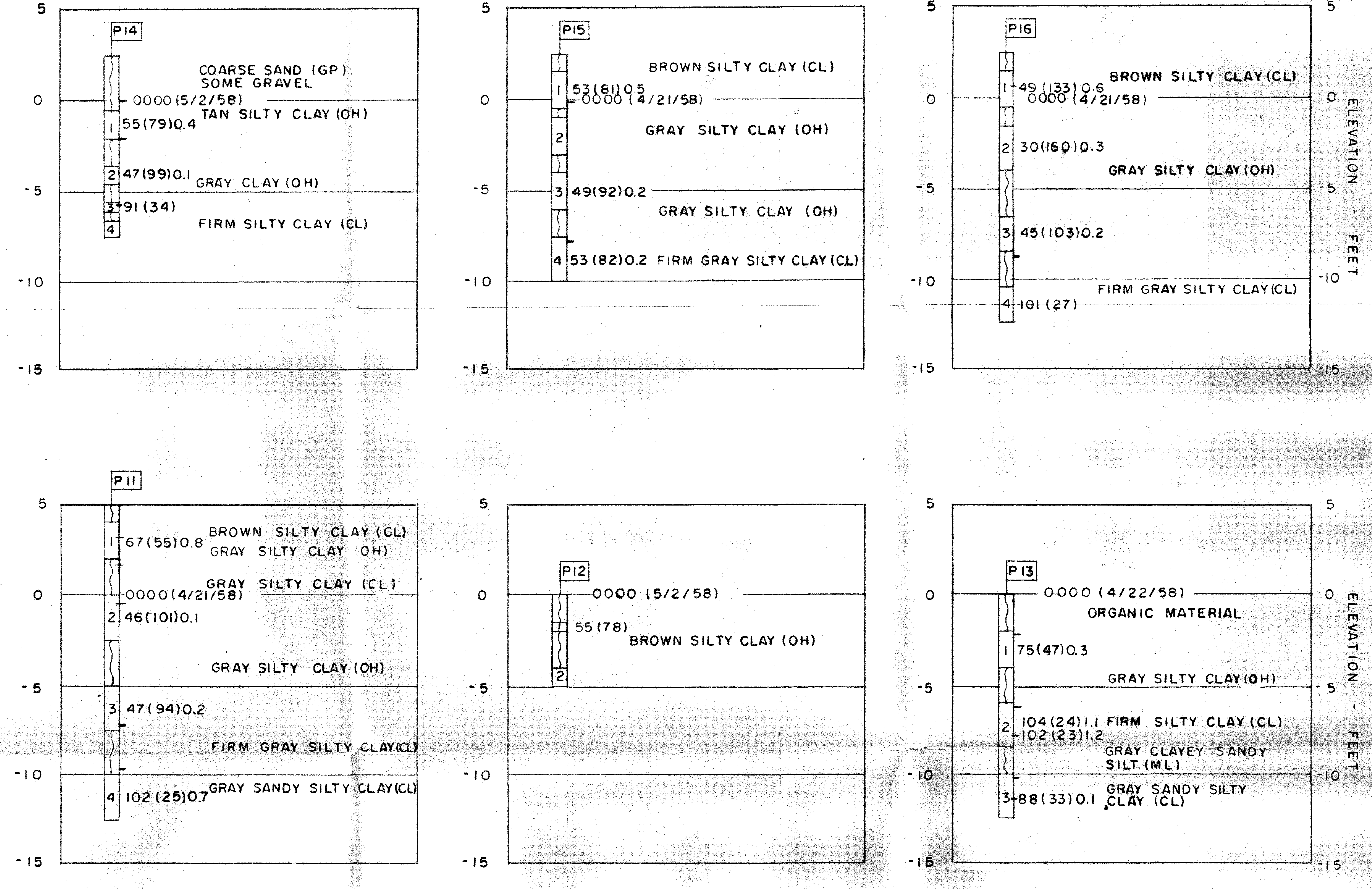
SCALE: 1" = 600'



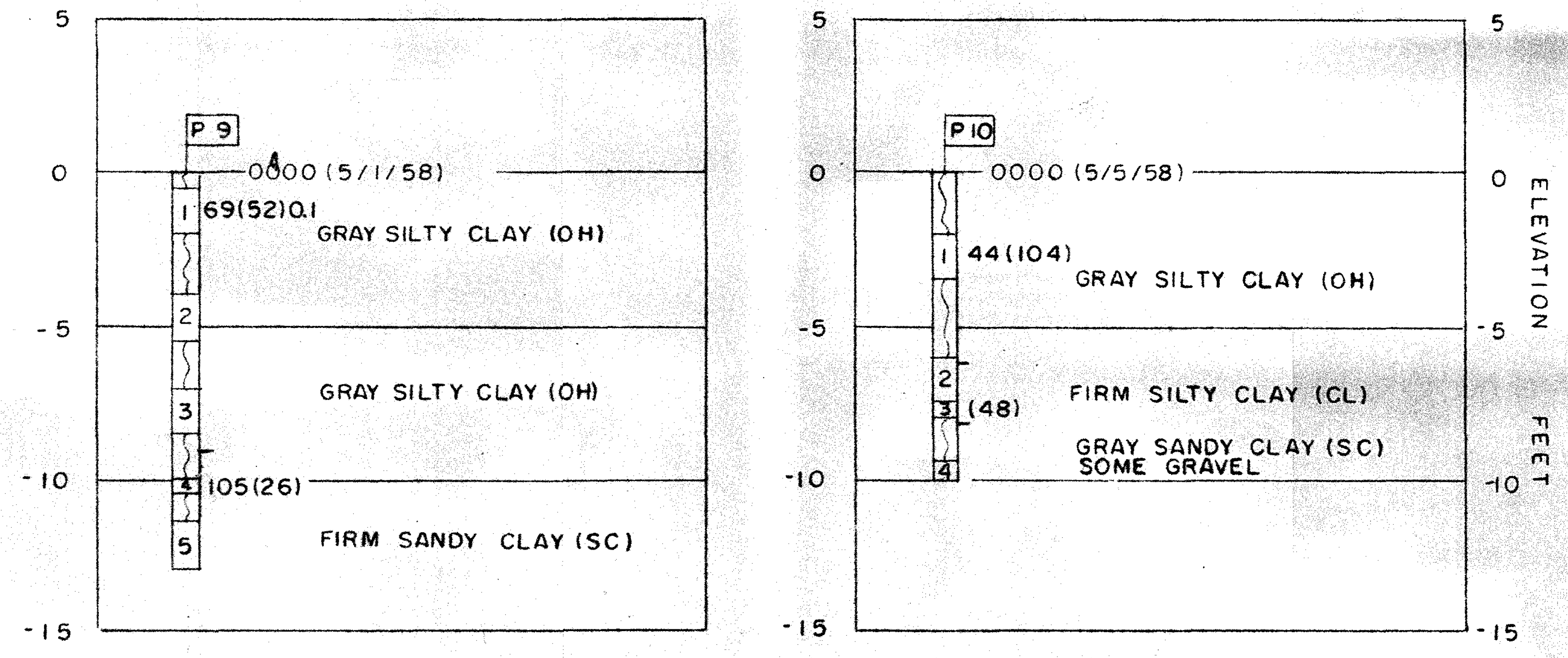
NOTE: ZERO DATUM - MEAN SEA LEVEL U.S.G.S.

SOIL PROFILE

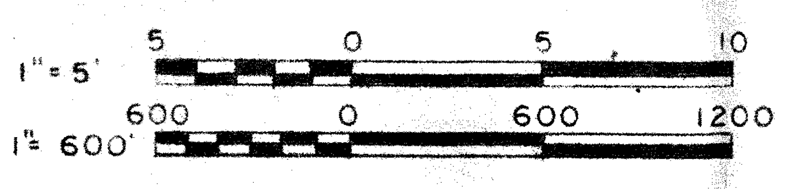
SCALE - HOR. 1" = 600'
VERT. 1" = 5'



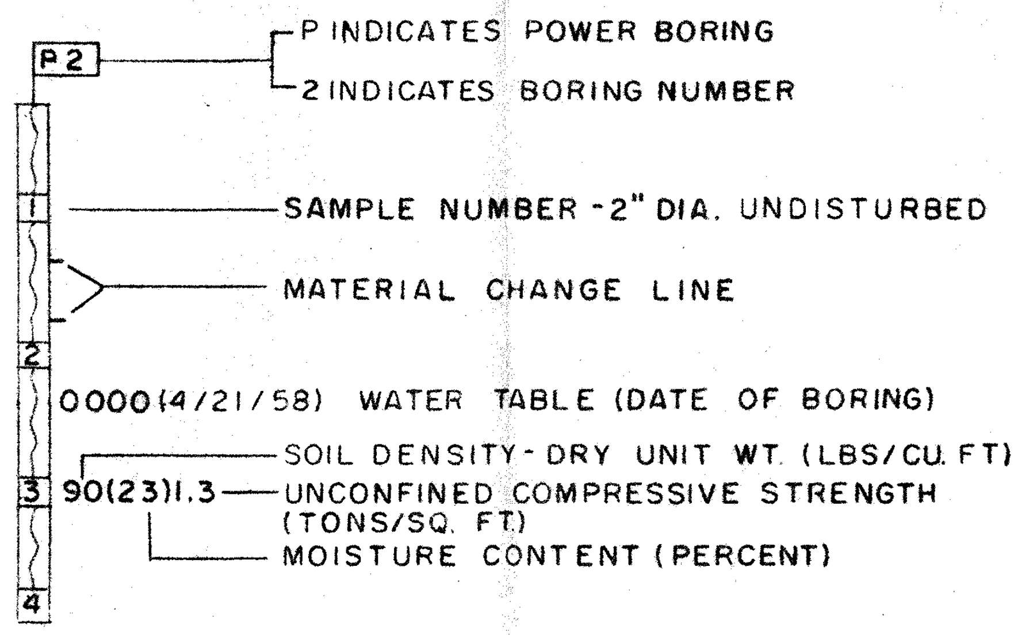
NOTE: ZERO DATUM (P9 THRU P16) OBSERVED WATER TABLE.



GRAPHIC SCALES



LEGEND



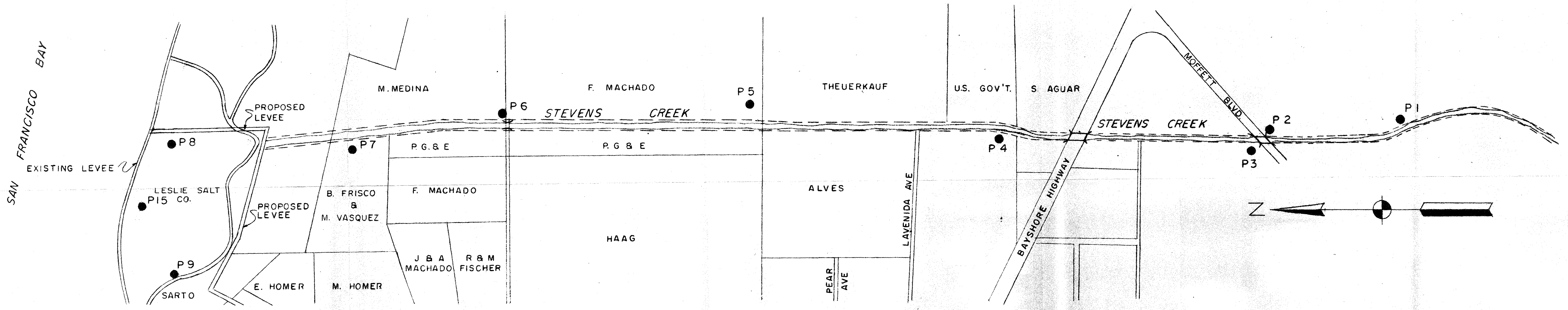
P INDICATES POWER BORING
2 INDICATES BORING NUMBER
SAMPLE NUMBER - 2" DIA. UNDISTURBED
MATERIAL CHANGE LINE
0000 (4/21/58) WATER TABLE (DATE OF BORING)
90(23)1.3 — SOIL DENSITY - DRY UNIT WT. (LBS/CU. FT.)
UNCONFINED COMPRESSIVE STRENGTH (TONS/SQ. FT.)
MOISTURE CONTENT (PERCENT)

STEVENS & PERMANENTE CREEK FLOOD CONTOL
SANTA CLARA COUNTY, CALIFORNIA

SOIL PROFILE & BORING LOCATION PLAN

PORTER, URQUHART, Mc CREARY & O'BRIEN
CONSULTING ENGINEERS

DATE: 5/13/58 PROJECT: 58-32
DRAWN BY K. CHECKED BY FWA
APPROVED BY C. L. Lawry Jr.
REG. CIVIL ENGR. NO. 8104
PLATE NO. 2



BORING LOCATION PLAN

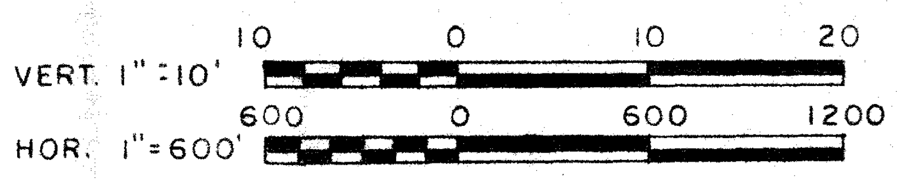
SCALE: 1" = 600'

SOIL PROFILE

SCALE = HOR. 1" = 600'
= VERT. 1" = 10'

NOTE: ZERO DATUM - MEAN SEA LEVEL U.S.G.S.

GRAPHIC SCALES

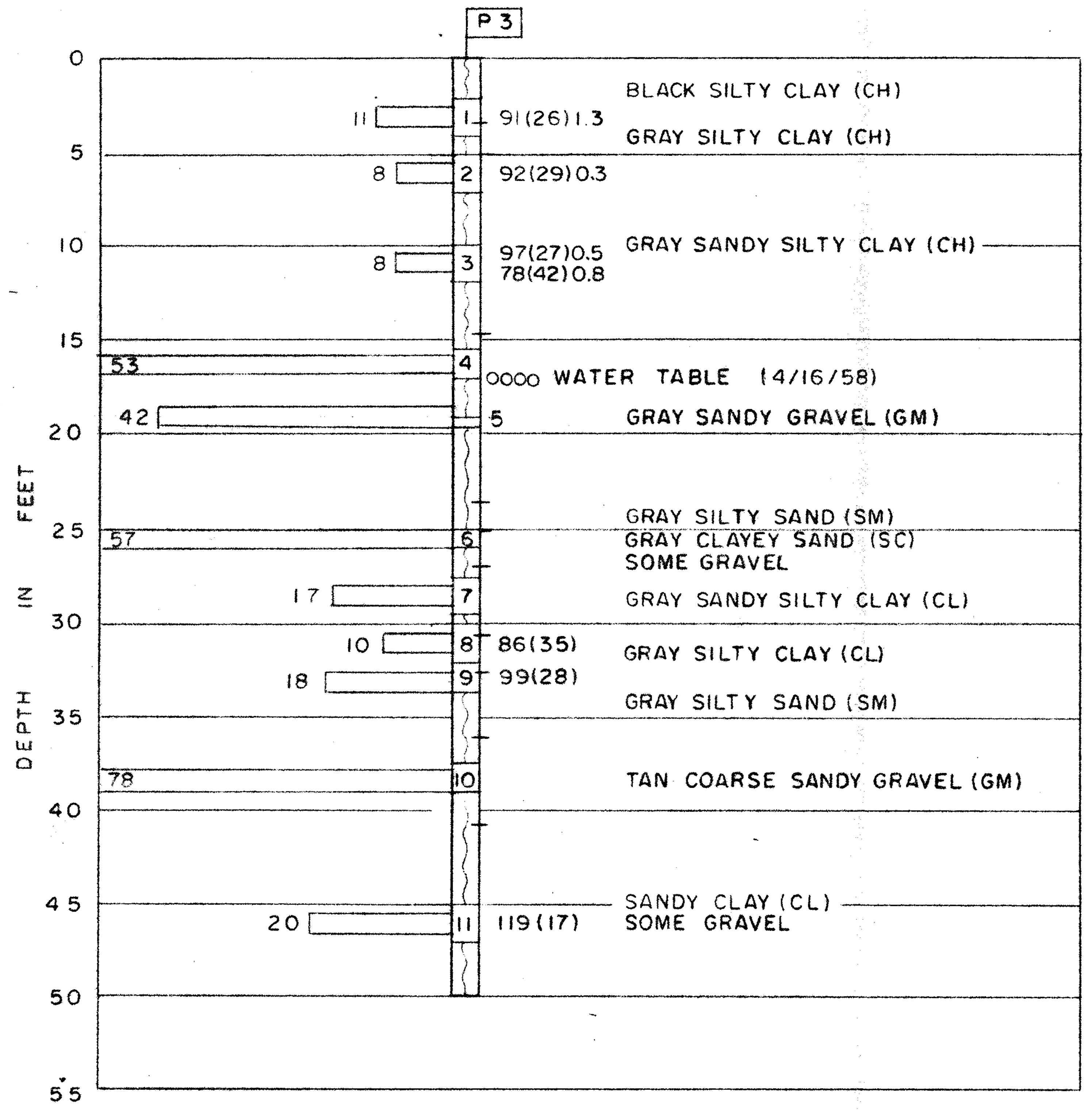


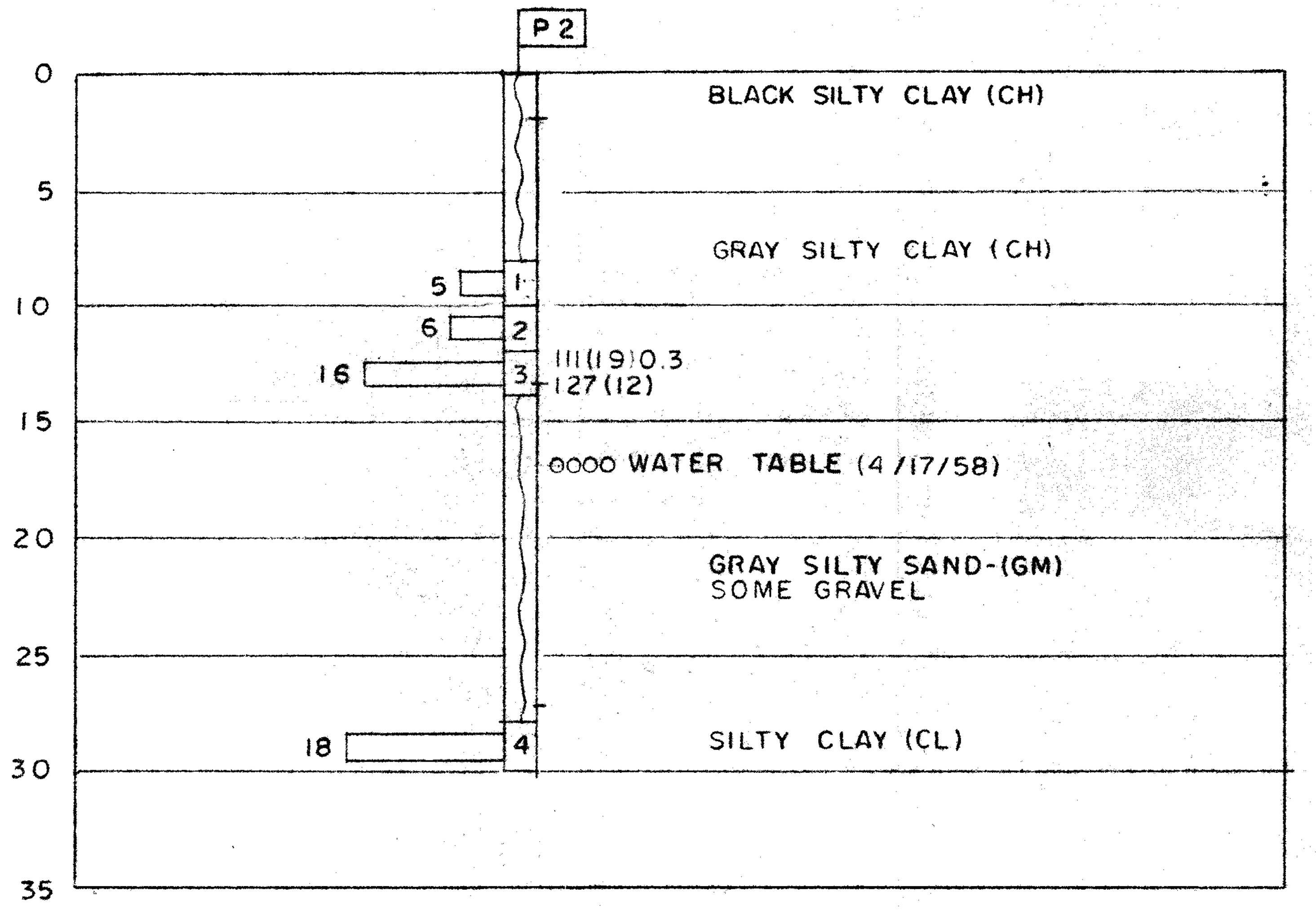
STEVENS CREEK FLOOD CONTOL
SANTA CLARA COUNTY, CALIFORNIA

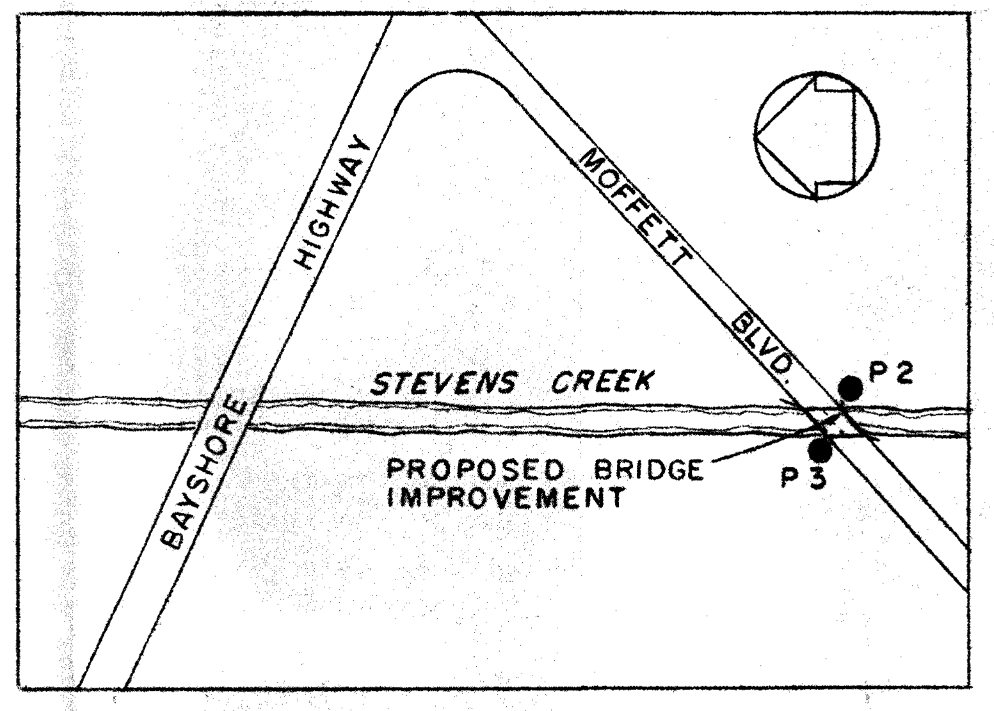
SOIL PROFILE
&
BORING LOCATION PLAN

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS

DATE: 5/12/58 PROJECT: 58-32
DRAWN BY HS CHECKED BY FWA
APPROVED BY C. L. Lowry Jr.
REG. CIVIL ENGR. NO. 9184
PLATE NO. 1

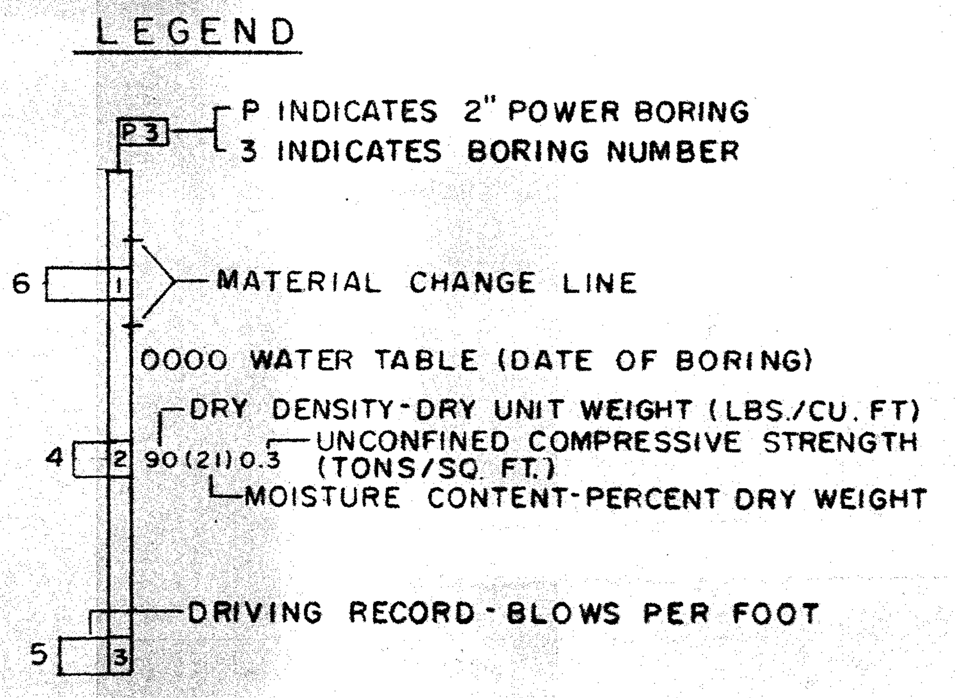


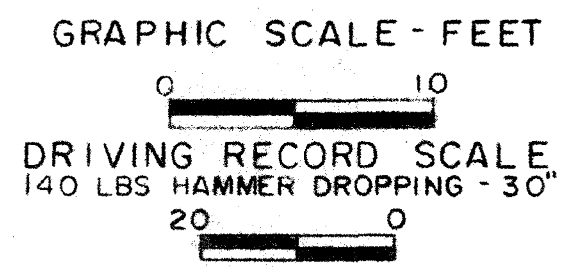




BORING LOCATION PLAN

NOT TO SCALE


LEGEND
P 3
P INDICATES 2" POWER BORING
3 INDICATES BORING NUMBER
6
1
MATERIAL CHANGE LINE
0000 WATER TABLE (DATE OF BORING)
4
2
90(21)0.3
DRY DENSITY-DRY UNIT WEIGHT (LBS./CU. FT)
UNCONFINED COMPRESSIVE STRENGTH (TONS/SQ. FT.)
MOISTURE CONTENT-PERCENT DRY WEIGHT
DRIVING RECORD-BLOWS PER FOOT
5
3

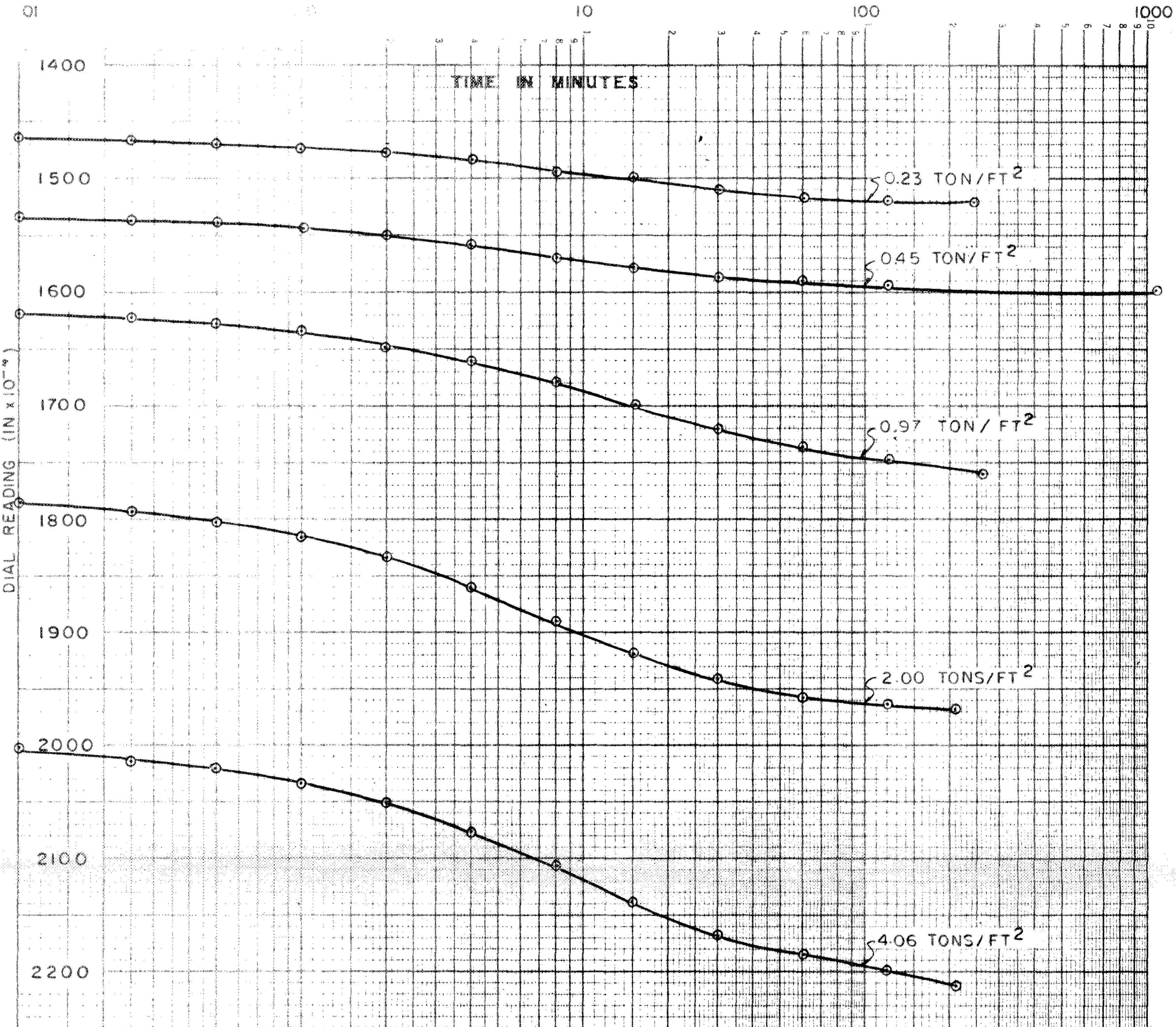


MOFFETT BLVD. BRIDGE SITE
SANTA CLARA COUNTY, CALIFORNIA

SOIL PROFILE

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS

DATE: 5/7/58 PROJECT: 58 - 32 DRAWN BY HK CHECKED BY FWA	APPROVED BY C. L. Lowry Jr. REG. CIVIL ENGR. NO. 2104	PLATE NO. 3



TIME CONSOLIDATION CURVES

TEST DATA

HOLE NO. P 2

SAMPLE NO. 3 - III

DEPTH (FT.) 13 FT.

ELEV. (FT.)

DRY UNIT WT. (LBS./CU. FT.) 79

MOISTURE CONTENT (% DRY WT.)

BEFORE TEST 44 %

AFTER TEST 36 %

SAMPLE HEIGHT (IN) 0.5"

DIAMETER (IN) 1.93"

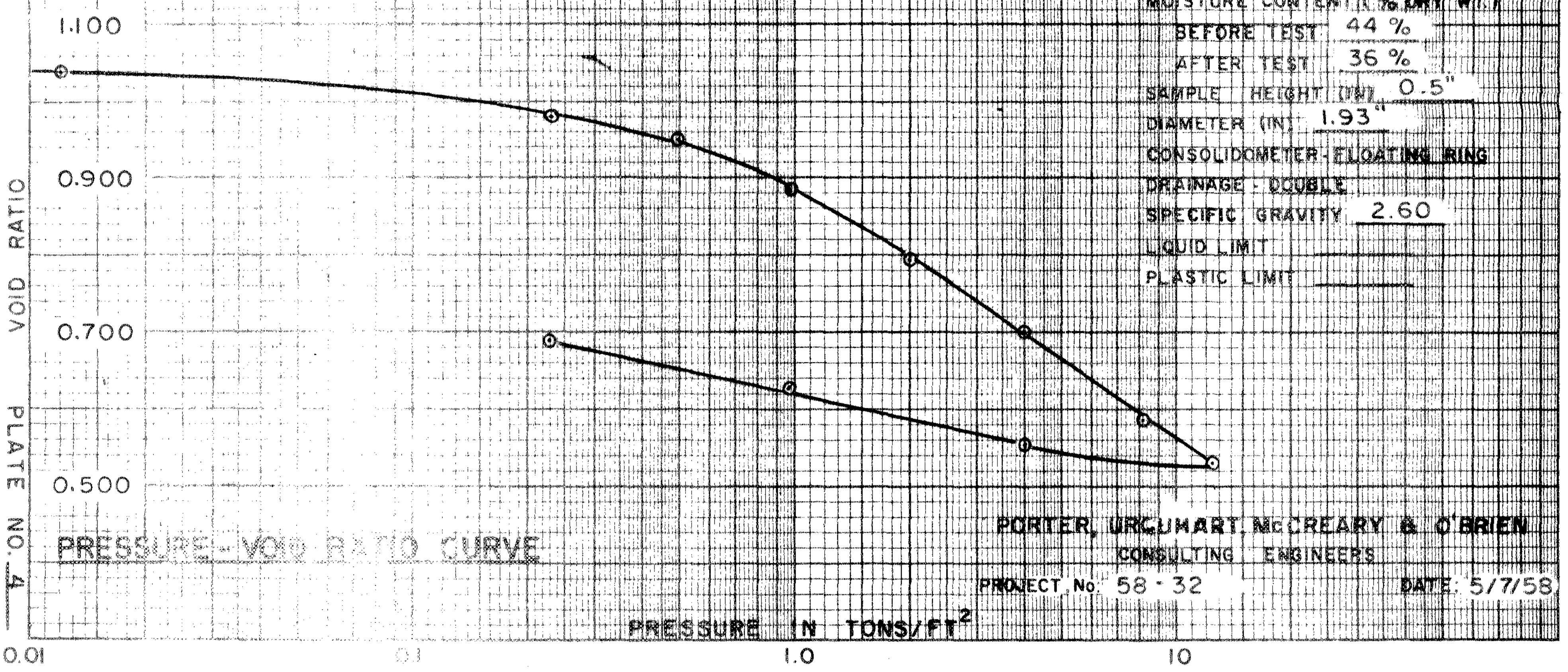
CONSOLIDOMETER - FLOATING RING

DRAINAGE - DOUBLE

SPECIFIC GRAVITY 2.60

LIQUID LIMIT

PLASTIC LIMIT



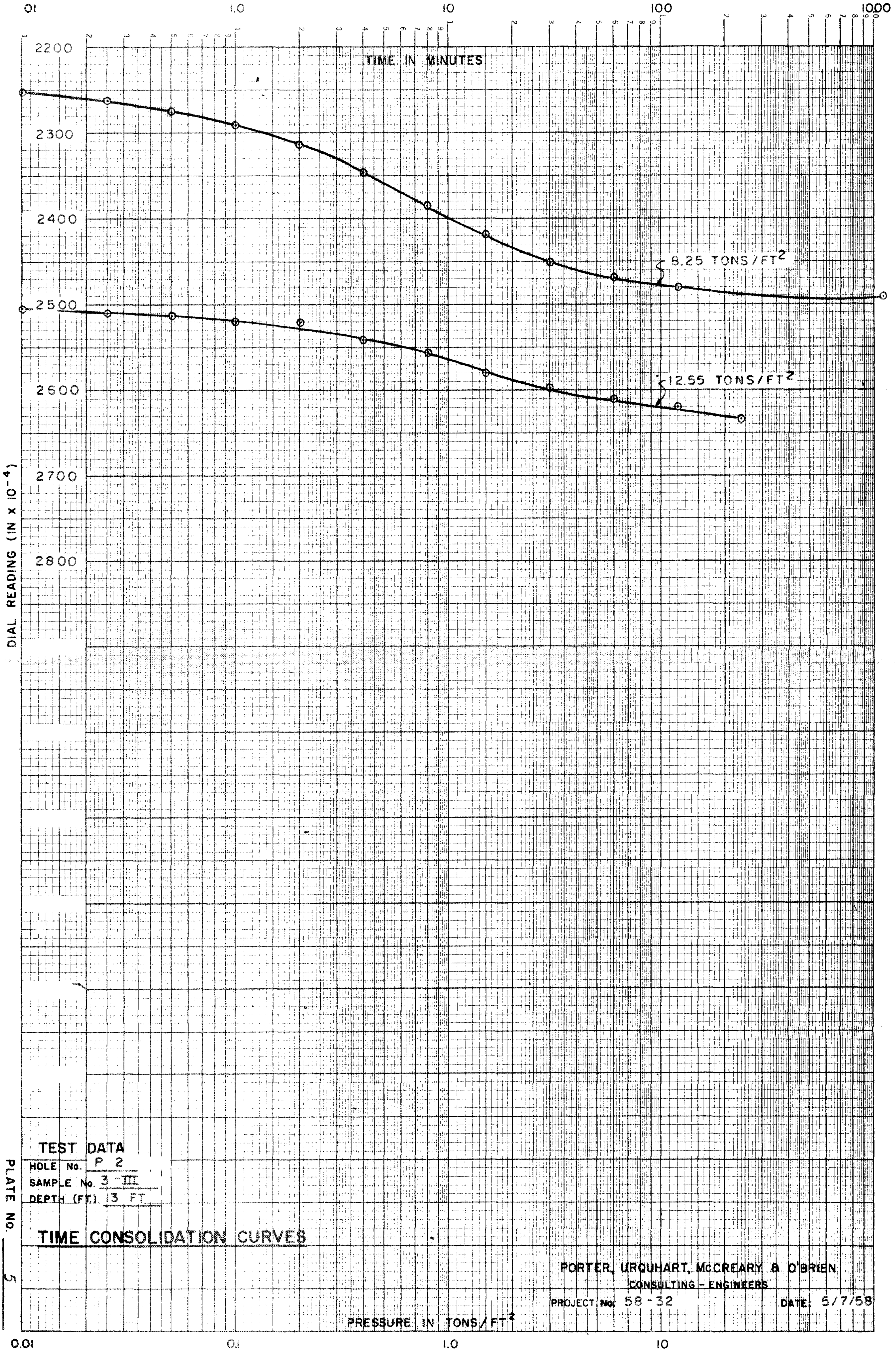
PRESSURE - VOID RATIO CURVE

PLATE NO. 4

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS

PROJECT No. 58 - 32

DATE: 5/7/58



TEST DATA

HOLE No. P 2

SAMPLE No. 3 - III

DEPTH (FT.) 13 FT

TIME CONSOLIDATION CURVES

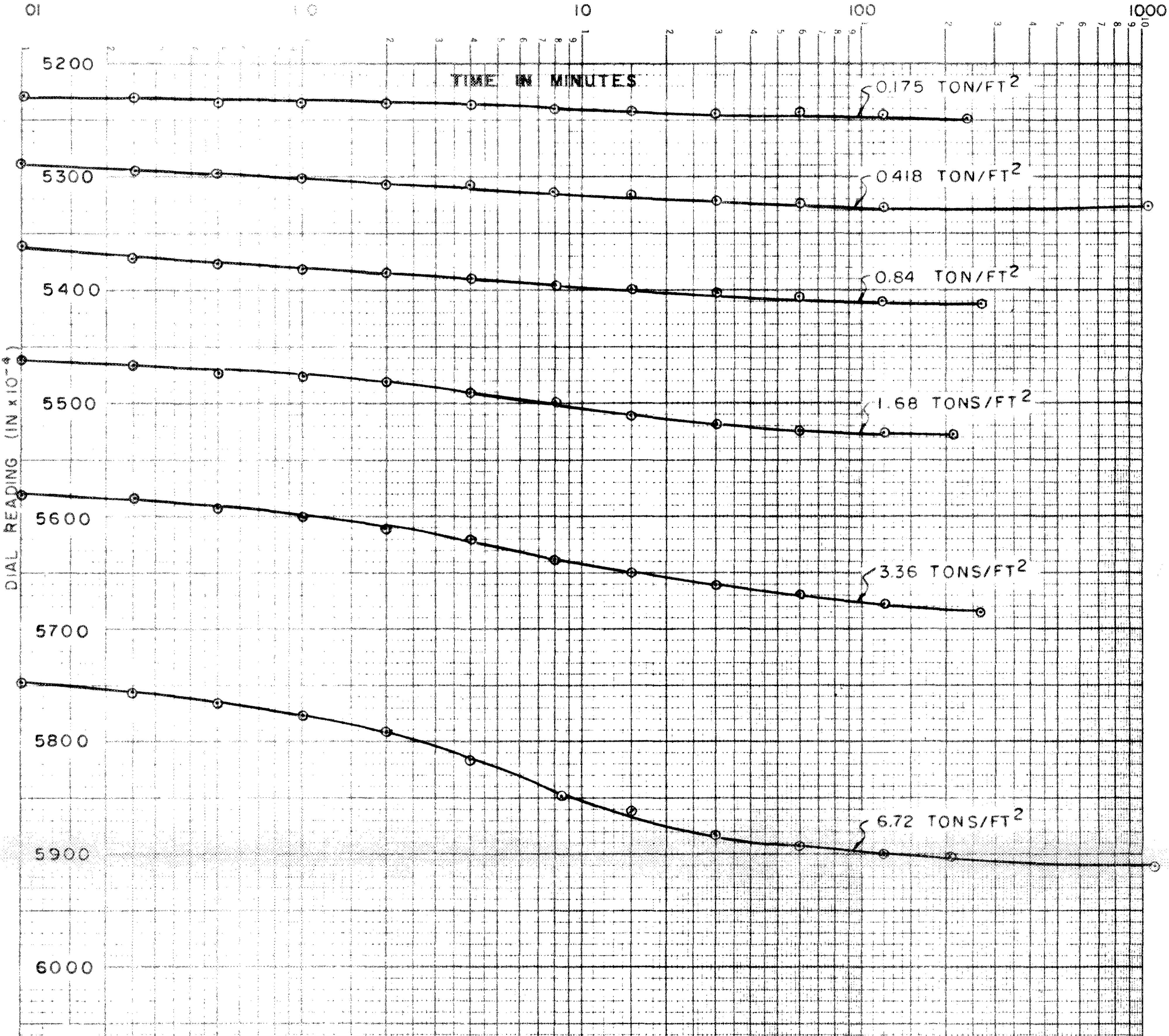
PORTER, URQUHART, McCREARY & O'BRIEN

CONSULTING - ENGINEERS

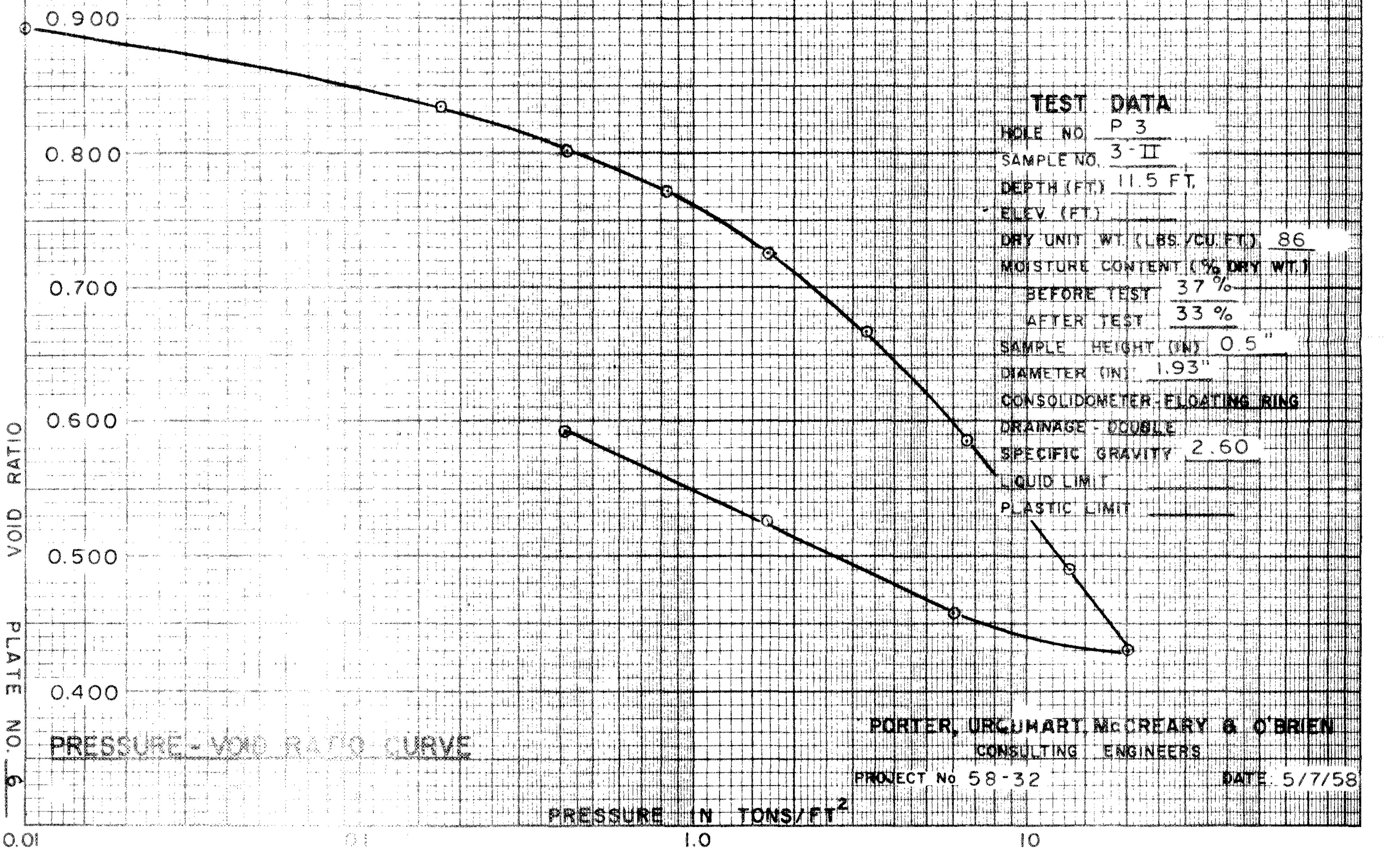
PROJECT No. 58 - 32

DATE: 5/7/58

PLATE NO. 5



TIME CONSOLIDATION CURVES



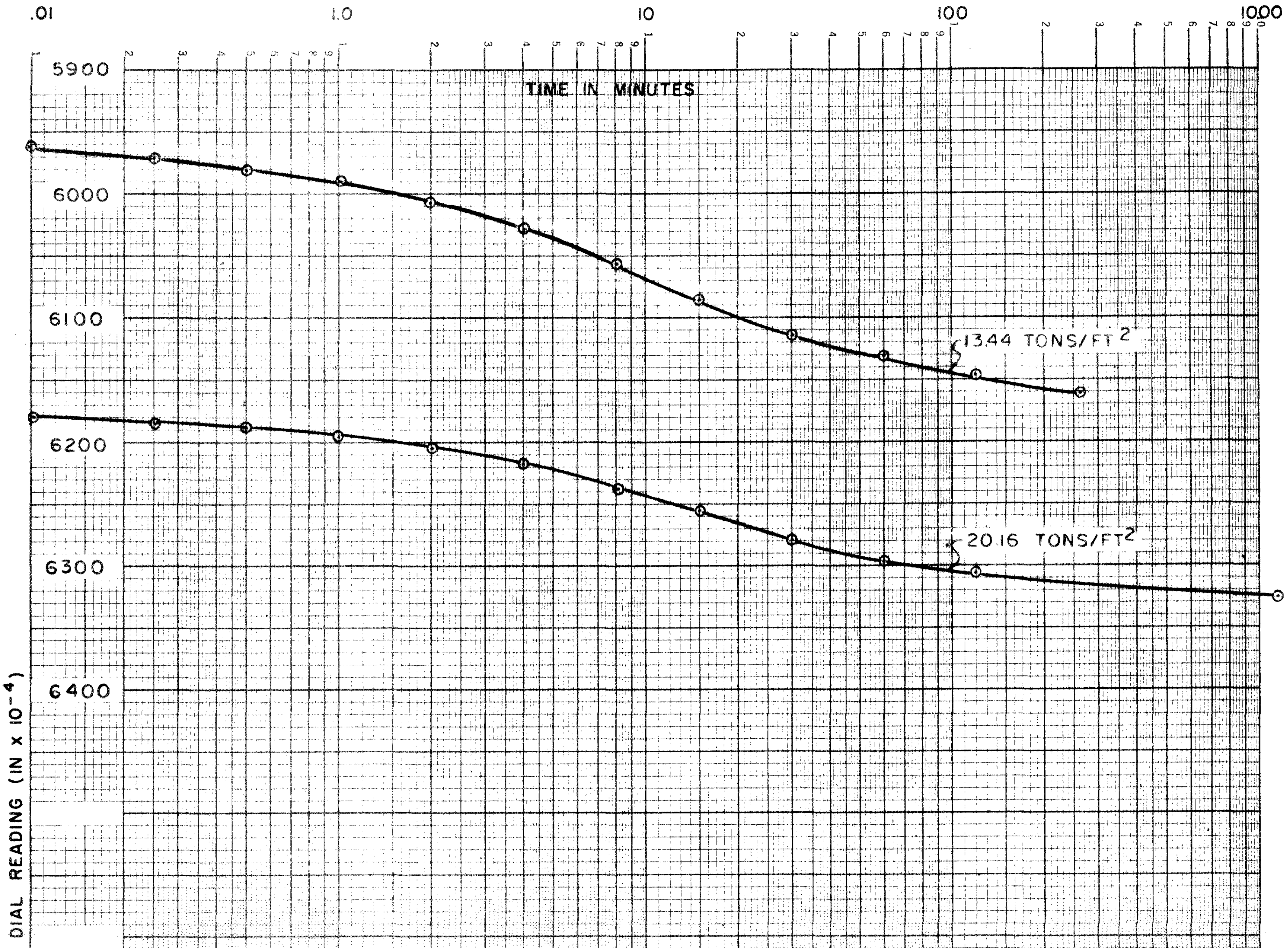
TEST DATA

HOLE NO P 3
SAMPLE NO. 3-II
DEPTH (FT) 11.5 FT.
ELEV. (FT)
DRY UNIT WT. (LBS./CU. FT.) 86
MOISTURE CONTENT (% DRY WT.)
BEFORE TEST 37 %
AFTER TEST 33 %
SAMPLE HEIGHT (IN) 0.5"
DIAMETER (IN) 1.93"
CONSOLIDOMETER - FLOATING RING
DRAINAGE - DOUBLE
SPECIFIC GRAVITY 2.60
LIQUID LIMIT
PLASTIC LIMIT

PRESSURE - VOID RATIO CURVE

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS
PROJECT No 58-32
DATE 5/7/58

PLATE NO. 6



TEST DATA

HOLE No. P 3

SAMPLE No. 3-II

DEPTH (FT.) 11.5 FT.

TIME CONSOLIDATION CURVES

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING - ENGINEERS

PROJECT No. 58-32

DATE: 5/7/58

PRESSURE IN TONS/FT^2

PLATE No. 7

PUMO FORM 104 2/58

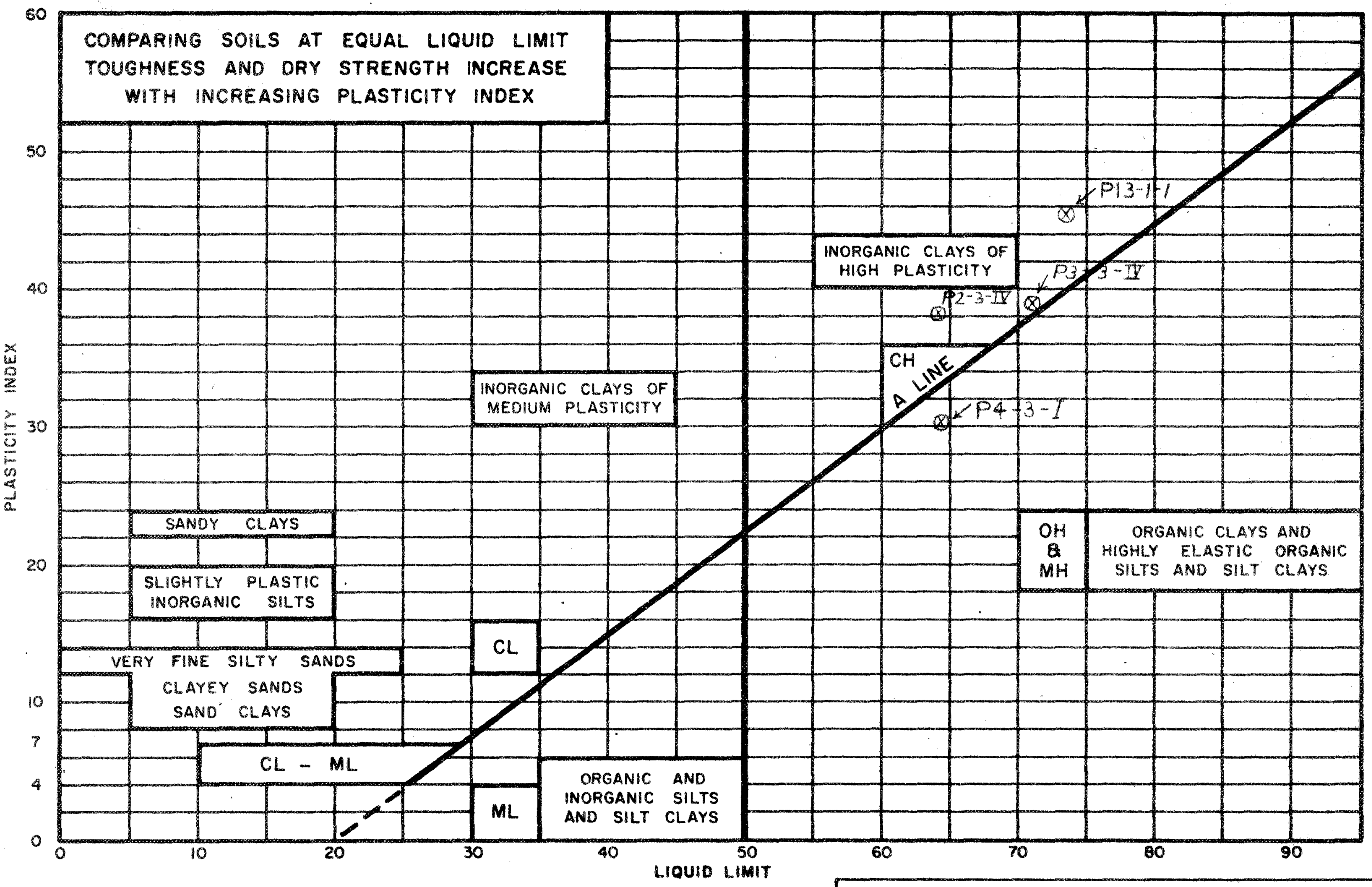


PLATE No.

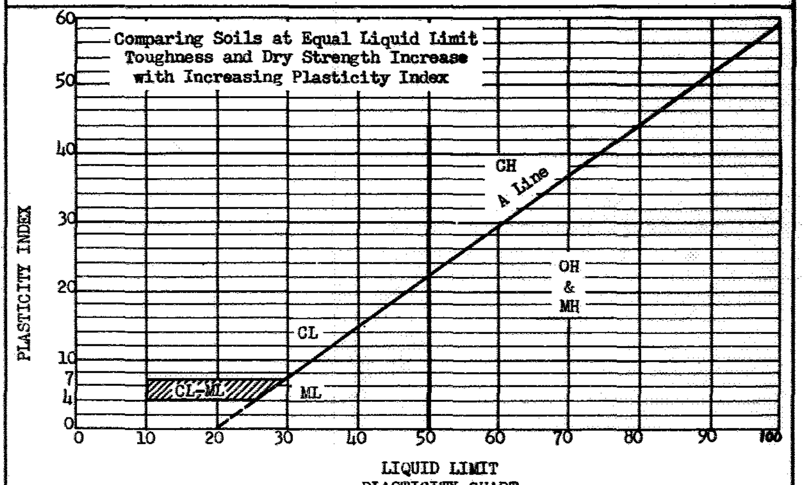
SANTA CLARA COUNTY FLOOD CONTROL
STEVENS & PERMANENTE CREEK
SANTA CLARA COUNTY, CALIF.

DATE: 5/15/58

PROJECT No: 58-32

PLASTICITY CHART

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING - ENGINEERS
SAN FRANCISCO

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)			Information Required for Describing Soils	Laboratory Classification Criteria			
1.	2.		3.	4.	5.			6.	7.			
Coarse-grained Soils More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size.	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	Use grain-size curve in identifying the fractions as given under field identification.	Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.						Not meeting all gradation requirements for GW	
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below.)			Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularily, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.			Atterberg limits below "A" line or PI less than 4.	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below.)						Atterberg limits above "A" line with PI greater than 7.	
	Sands More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size.)	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.						$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).			Not meeting all gradation requirements for SW	
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).						Atterberg limits below "A" line or PI less than 4.	Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).						Atterberg limits above "A" line with PI greater than 7.	
Fine-grained Soils More than half of material is smaller than No. 200 sieve size.					Identification Procedures on Fraction Smaller than No. 40 Sieve Size							
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)					
	Silts and Clays Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses.		 PLASTICITY CHART For laboratory classification of fine-grained soils		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium					
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.				
	Silts and Clays Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium					
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High	Example: Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).				
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium					
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.							

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder.
(2) All sieve sizes on this chart are U.S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing Characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of sand about 1/2 inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 1/8 inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

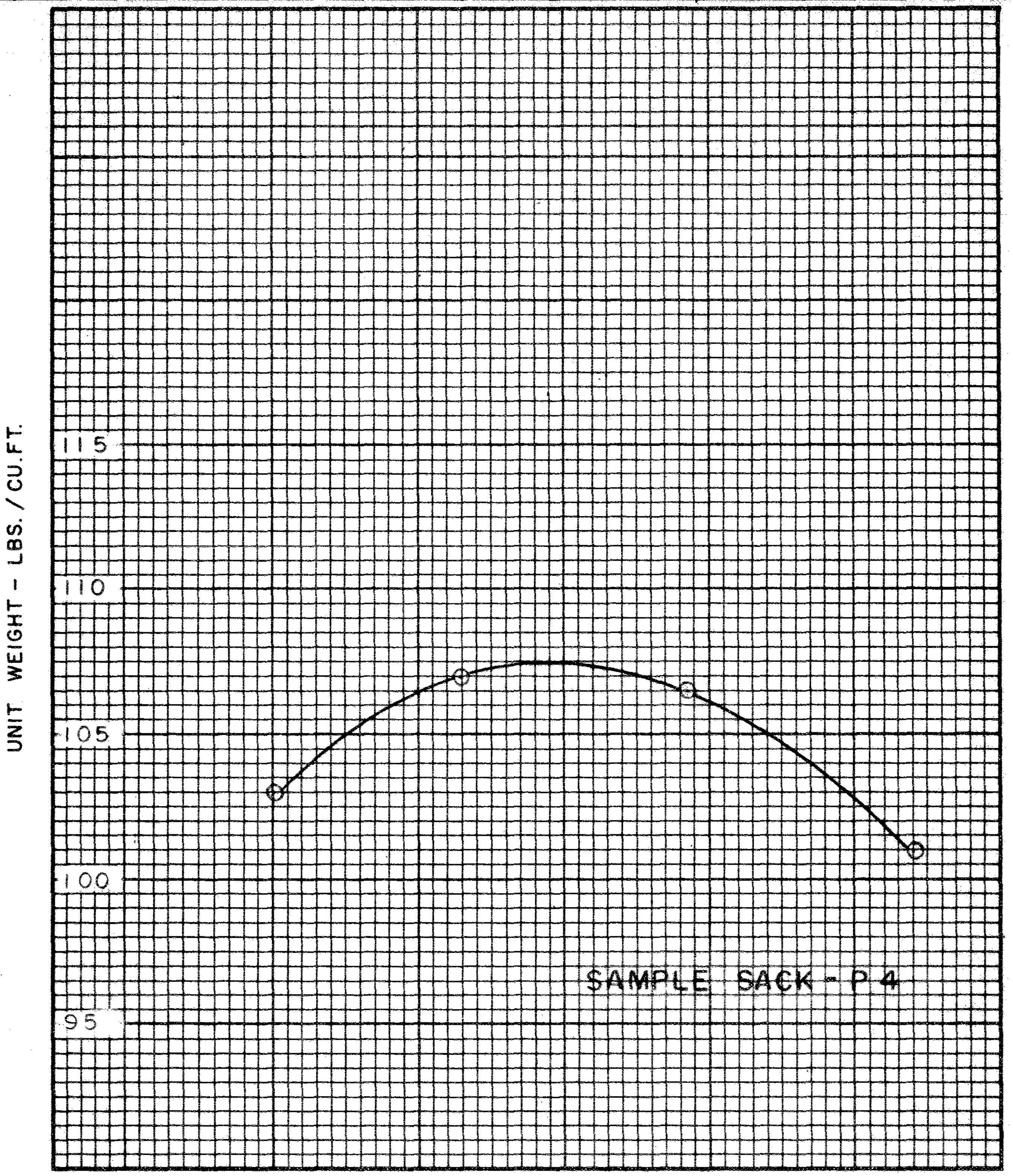
Highly organic clays have a very weak and spongy feel at the plastic limit.

Note: Reference, Technical Memorandum No. 3-357, Volume 1, March 1953, by Waterways Experiment Station, Vicksburg, Mississippi.

PORTER, URQUHART, McCREARY, & O'BRIEN
CONSULTING ENGINEERS

UNIFIED SOIL CLASSIFICATION
INCLUDING IDENTIFICATION
AND DESCRIPTION

DATE: JANUARY, 1954
Plate No. 9



TEST DATA

MATERIAL: GRAY GRAVELLY CLAY
TYPE OF TEST: MODIFIED AASHO T99-49
MAXIMUM DRY DENSITY (LBS./CU.FT.): 107.5
OPTIMUM MOISTURE CONTENT (%): 17.8
SPECIFIC GRAVITY:
LIQUID LIMIT:
PLASTIC LIMIT:

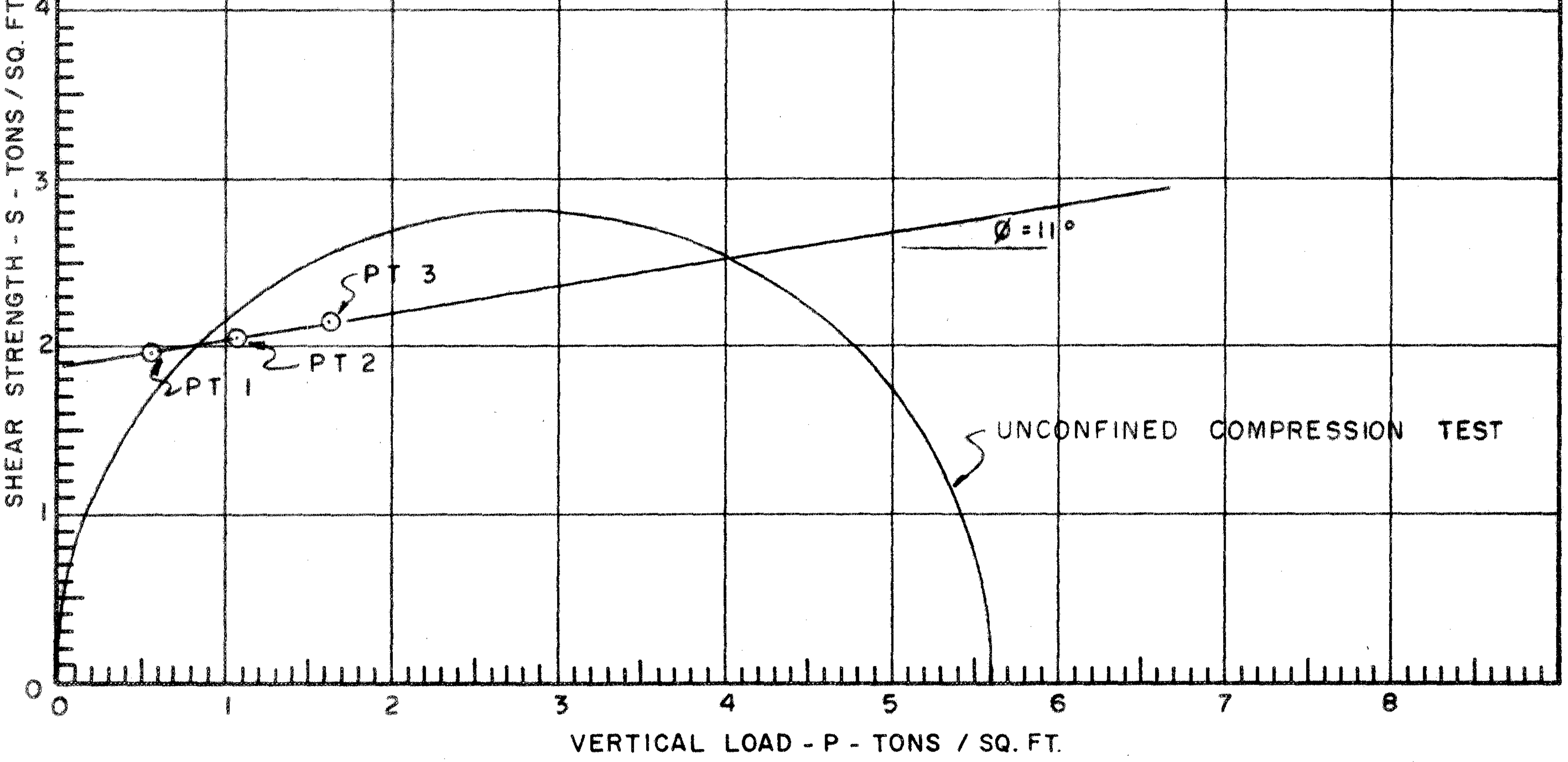
DATE: 5/16/58

PROJECT No: 58-32

COMPACTION TEST

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING - ENGINEERS
SAN FRANCISCO

SAMPLE No:	DRY DENSITY (LBS. / CU. FT.):	NATURAL MOISTURE CONTENT (%):	TEST MOISTURE CONTENT (%):	DEGREE OF SATURATION (%):
PT 1	101.5	23.0	26.0	
PT 2	100.0	24.0	26.0	
PT 3	100.0	23.0	27.0	



TEST DATA

MATERIAL DESCRIPTION: GRAY CLAY - SOME GRAVEL

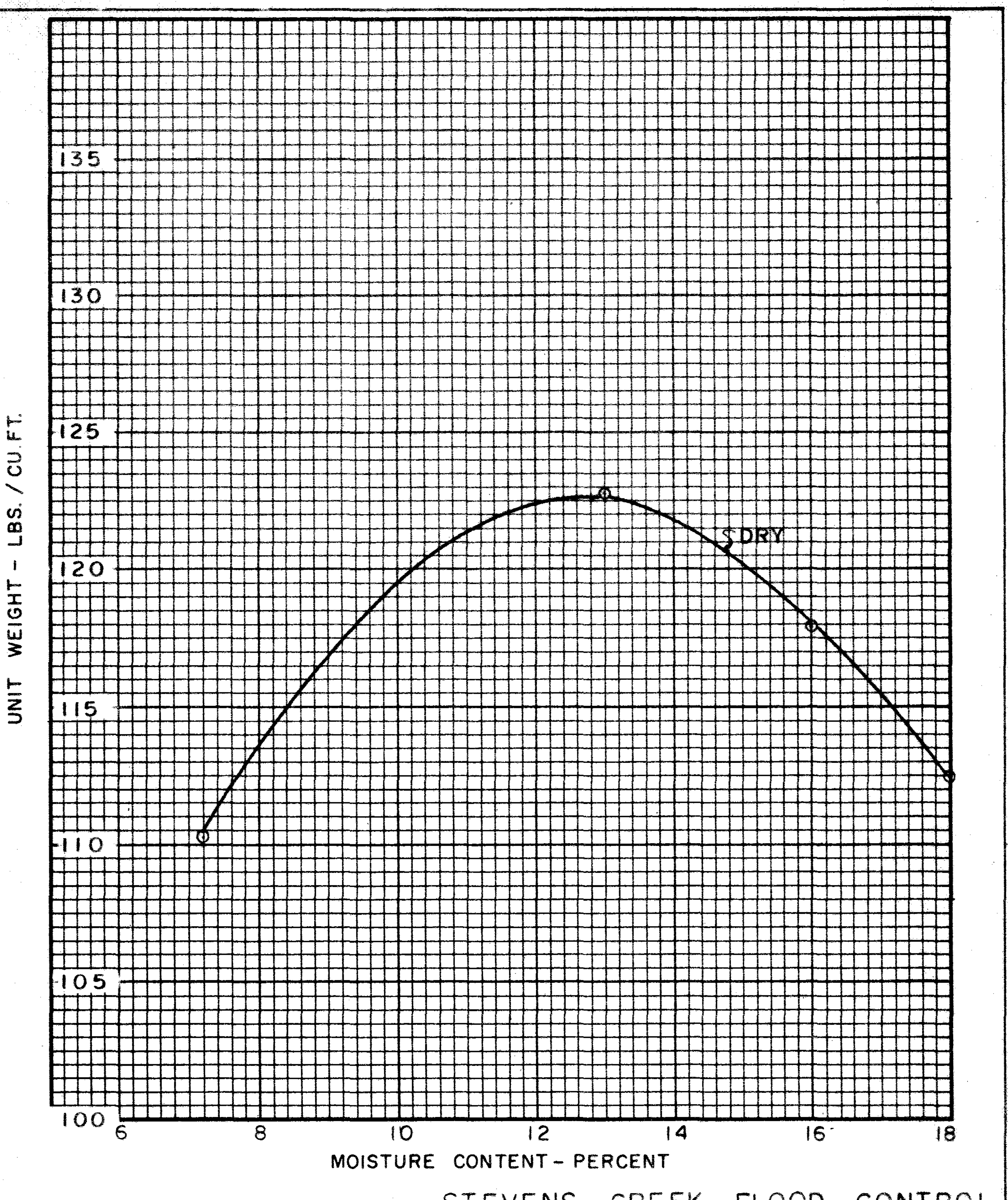
SAMPLE CONDITION: COMPACTED

TYPE OF TEST: QUICK

DATE: 6/6/58 PROJECT No: 58-32

DIRECT SHEAR TEST

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING - ENGINEERS
SAN FRANCISCO



TEST DATA

MATERIAL: SANDY GRAVEL & BLACK SILTY CLAY - COMBINED

TYPE OF TEST: MODIFIED AASHO T 99-49

MAXIMUM DRY DENSITY (LBS./CU.FT.): 122.7

OPTIMUM MOISTURE CONTENT (%): 13

SPECIFIC GRAVITY:

LIQUID LIMIT:

PLASTIC LIMIT:

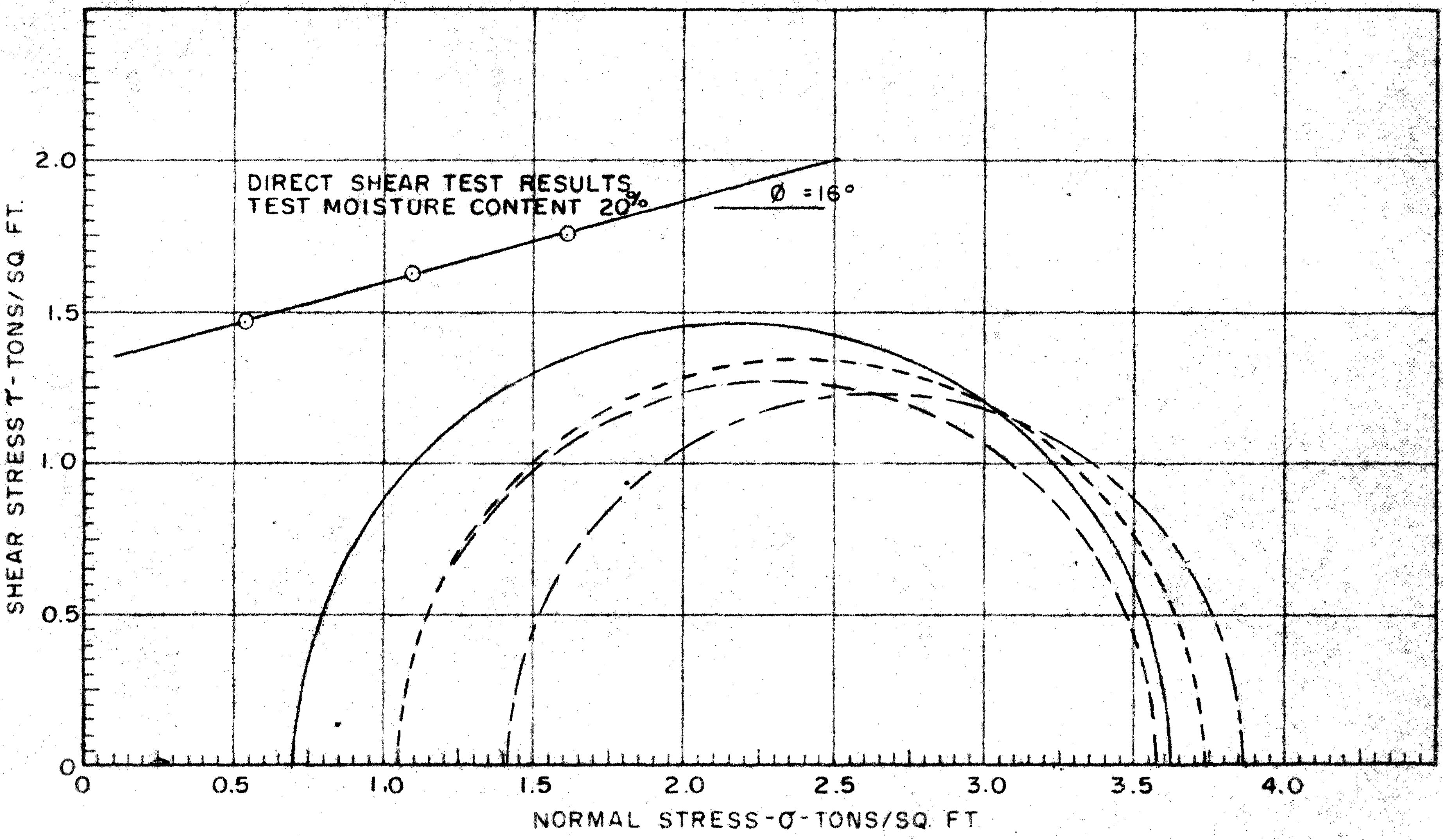
STEVENS CREEK FLOOD CONTROL
SANTA CLARA COUNTY, CALIF.

DATE: 5/8/58

PROJECT No: 58-32

COMPACTION TEST

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING - ENGINEERS
SAN FRANCISCO



TEST DATA

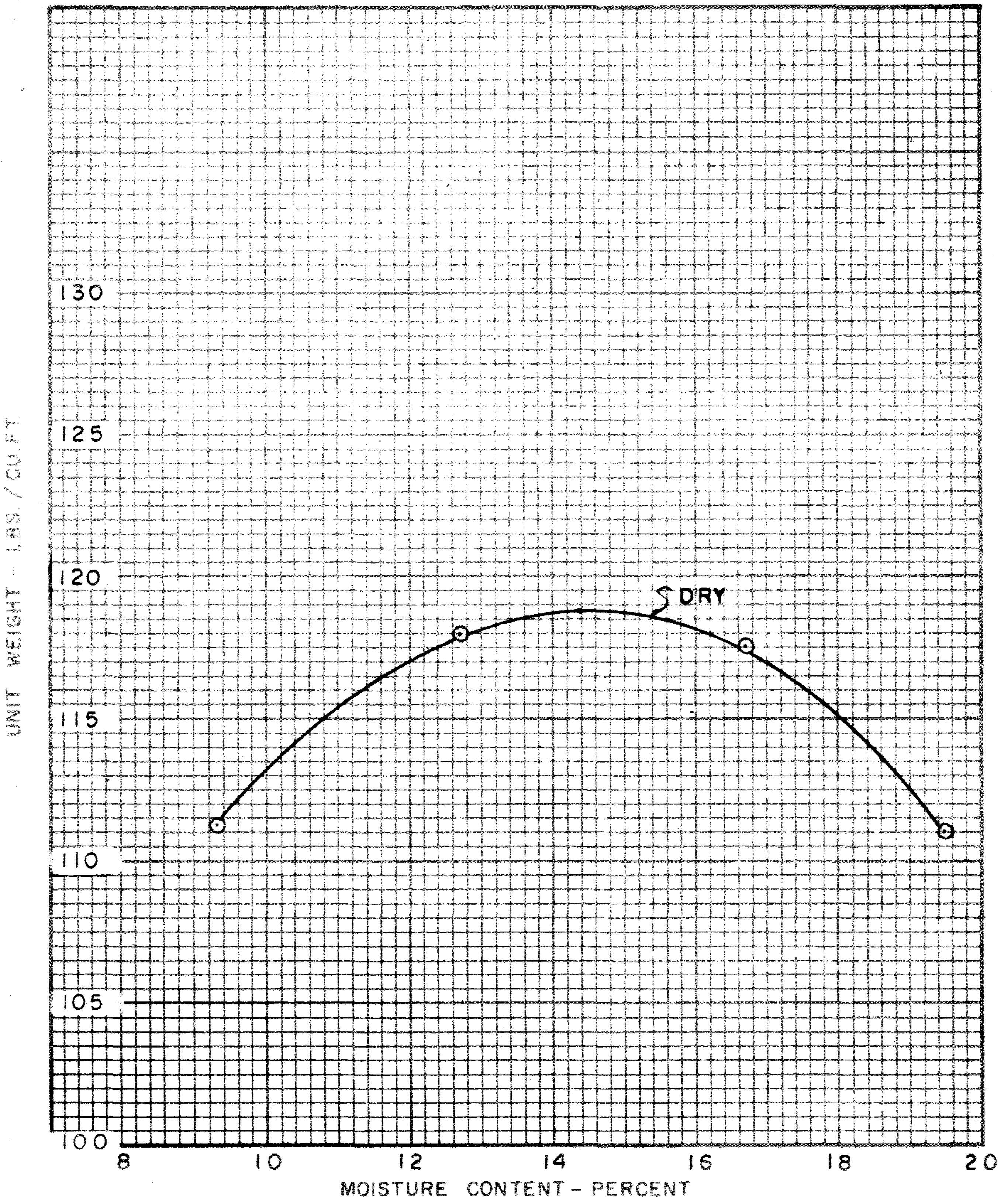
MATERIAL DESCRIPTION: BLACK SILTY CLAY & GRAVEL (COMBINED)
SAMPLE CONDITION: COMPACTED
TYPE OF TEST: QUICK
DRY DENSITY (LBS./CU.FT.): 116
NATURAL MOISTURE CONTENT (%): 17
TEST MOISTURE CONTENT (%): 19
DEGREE OF SATURATION (%): 100 %

STEVENS CREEK FLOOD CONTROL
SANTA CLARA COUNTY, CALIF.

TRIAXIAL COMPRESSION TEST

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS

DATE: 5/16/58
JOB NO: 58-32



TEST DATA

MATERIAL: SANDY GRAVEL & BLACK SANDY CLAY - COMBINED

TYPE OF TEST: MODIFIED AASHO T99-49

MAXIMUM DRY DENSITY (LBS./CU.FT.): 118.8

OPTIMUM MOISTURE CONTENT (%): 14.5

SPECIFIC GRAVITY:

LIQUID LIMIT:

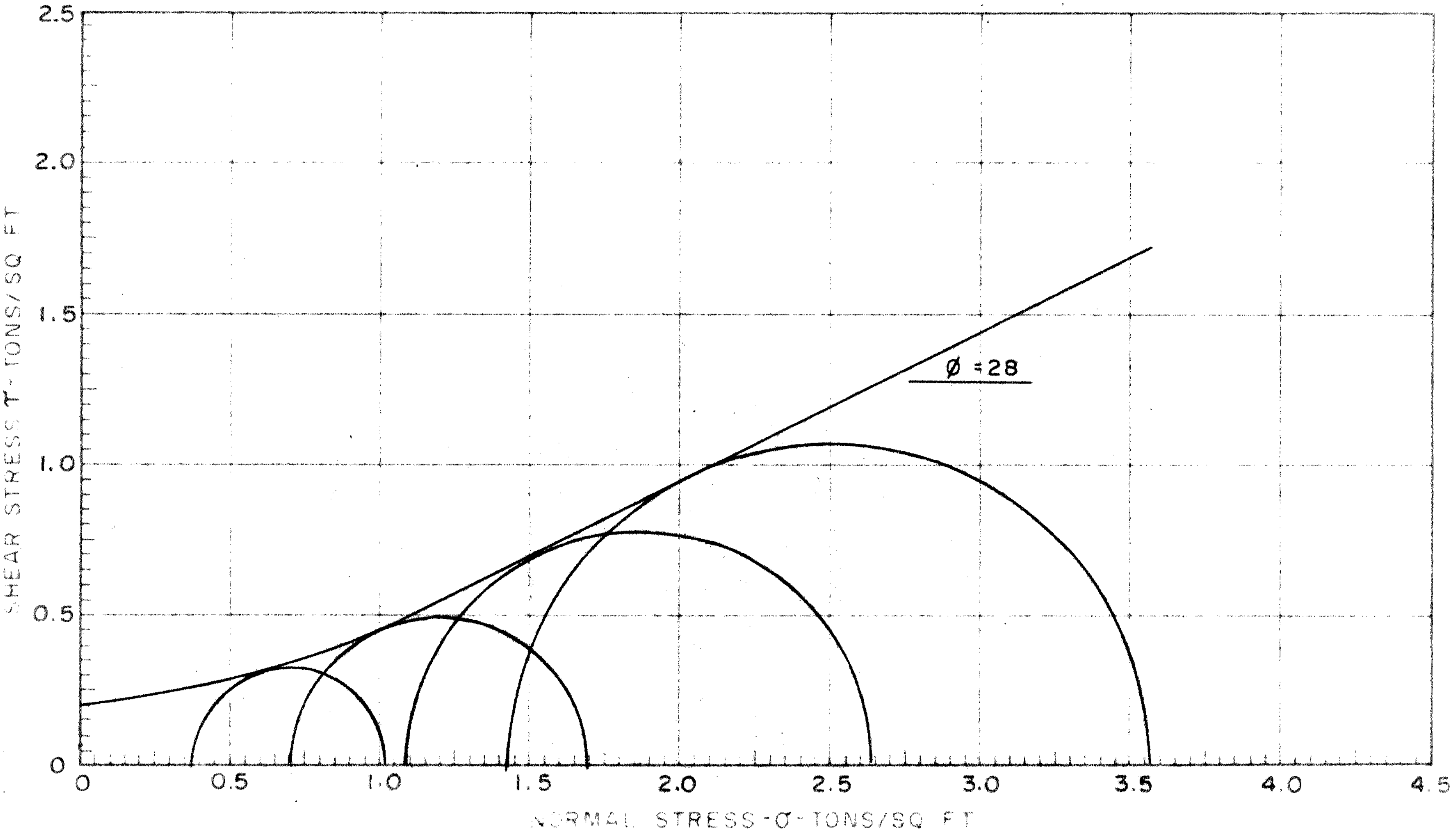
PLASTIC LIMIT:

PERMANENTE CREEK FLOOD CONTROL
SANTA CLARA COUNTY, CALIF

DATE: 5/16/58 PROJECT No 58-32

COMPACTION TEST

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING - ENGINEERS
SAN FRANCISCO



TEST DATA

MATERIAL DESCRIPTION SANDY GRAVEL & BLACK SANDY CLAY COMBINED
SAMPLE CONDITION COMPACTED
TYPE OF TEST: QUICK
DRY DENSITY (LBS/CU FT) 110.0
NATURAL MOISTURE CONTENT (%) 18.5
TEST MOISTURE CONTENT (%) 21
DEGREE OF SATURATION (%) 100 %

PERMANENTE CREEK FLOOD CONTROL
SANTA CLARA COUNTY, CALIF

TRIAXIAL COMPRESSION TEST

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS

DATE 5-16-58
JOB NO 58-32

PLATE NO.

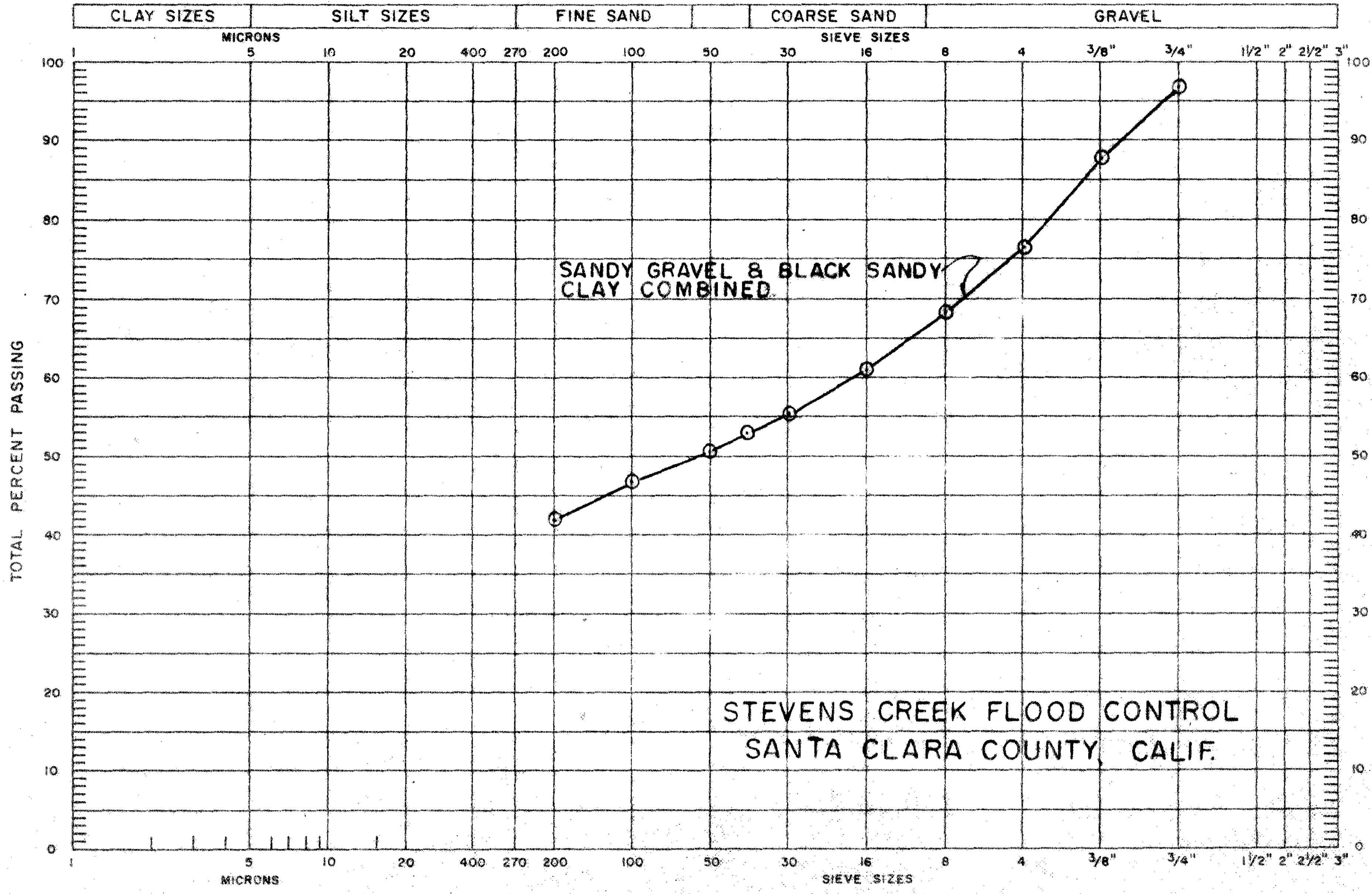
PUMO FORM 105 2/58

PORTER, URQUHART, McCREARY & O'BRIEN
CONSULTING ENGINEERS
SACRAMENTO SAN FRANCISCO LOS ANGELES

DATE: 5/16/58

PROJECT No: 58-32

GRADING ANALYSIS



STEVENS CREEK FLOOD CONTROL
SANTA CLARA COUNTY, CALIF.